

cluding even some of the *Oldhamiæ*, Eophytons, and Fucoids. Nor does he seem to be aware that two head-portions of *Palæopyge* (p. 167) have been found and published, thus removing it from the category of the doubtfuls.

Dr. Nicholson's illustrations are numerous and apt. They have been selected for the most part from such as the Geological Survey of Canada, Principal Dawson (author of 'Acadian Geology'), the publishers of D'Orbigny's 'Cours élémentaire,' and, he might have added, Page's 'Text-book' and his own 'Text-book of Zoology' have supplied him with. Why the wretched Ventriculite at p. 70 should claim its paternity so boastfully from "Lyell" is not clear. That the authorship of some only, and not of all the cuts (often as they may have been used before), should have been acknowledged is to be regretted; for if the real origin of all the figures were carefully indicated, the student might have the opportunity of learning something more of the history of genera and species by referring to the original observers. Not but that many authors are mentioned in the text: by following, however, a good example in this matter, such as Dana's excellent 'Manual of Geology,' Dr. Nicholson would have improved his well-designed book; and he would probably have been reminded that the Russian Mammoth skeleton (p. 445) is always a puzzle to tyros on account of its unexplained head-skin and shapeless hoofs, that the Ichthyosaur at p. 369, with outlined body, ought to have a fluked tail in the figure as well as in the text, and that Mr. S. V. Wood's fine Alligator-relic, at p. 367, is an *upper* and not a *lower* jaw.

MISCELLANEOUS.

Anatomical Investigations on the Limuli. By A. MILNE-EDWARDS.

ON June 26, 1869, I communicated to the Philomathic Society the first part of an investigation which I had just made upon the anatomy of the *Limuli*; and a short abstract of this communication was inserted in the 'Bulletin' of that learned Society and in the 'Journal de l'Institut.' This memoir, accompanied by numerous figures, ought to have been printed soon afterwards; but the unhappy circumstances under which France laboured in 1870 and 1871 prevented its publication, and it is only now that I am able to bring it out in its entirety.

The first notions that we possess as to the internal organization of the *Limuli* date from 1828, and are due to Strauss-Dürckheim. Ten years afterwards Van der Hoeven published on the whole group a very carefully executed monograph; but all the anatomical part of his work, which was studied by means of individuals preserved in spirit, leaves much to be desired, and we observe in it serious errors, which, however, it was almost impossible to avoid under the circumstances in which this author found himself.

About the same time Duvernoy added some details to what was previously known as to the respiratory apparatus of the *Limuli*. In

1855, Professor Owen inserted in his 'Lectures on the Anatomy of Invertebrata' various facts with regard to the structure of these singular Arthropoda; and quite recently an English journal announced that this illustrious naturalist had resumed the investigation of the same subject; but his work is as yet known only by an abstract published in 1871. Some points relating to the histology of the *Limuli* have been treated by M. Gegenbaur; and works of great interest on the habits of these animals, on their embryology, and on their zoological affinities, have been published by MM. Lockwood, Packard, Dohrn, and E. van Beneden. Finally, Mr. Woodward, in several consecutive memoirs, has presented us with very interesting observations upon the relations of the *Limuli* with the Trilobites, the *Pterygoti*, and various articulate animals, the remains of which occur in the fossil state in the Silurian, Devonian, and Carboniferous formations.

I have no intention of discussing here the questions relating to the zoological affinities which may exist between the *Limuli* and the extinct species of ancient geological periods. My observations relate to the anatomy of these animals, and principally to the constitution of their circulatory apparatus and to the structure of their nervous system.

The circulatory apparatus of the *Limuli* is more perfect and complicated than that of any other articulate animal. The venous blood, instead of being diffused through interorganic lacunæ, as in the Crustacea, is for a considerable portion of its course enclosed in proper vessels with walls perfectly distinct from the adjacent organs, originating frequently by ramifications of remarkable delicacy, and opening into reservoirs which are for the most part well circumscribed. The nutritive liquid passes from these reservoirs into the branchiæ, and, after having traversed these respiratory organs, arrives, by a system of branchio-cardiac canals, in a pericardiac chamber, then penetrates into the heart, of which the dimensions are very considerable. It is then driven into tubular arteries with resistant walls, the arrangement of which is exceedingly complex, with frequent anastomoses, and of which the terminal ramifications are of marvellous tenuity and abundance. By making use of the microscope we can trace them, with their contours still well defined, even into the substance of the finest and most transparent membranes (for example, the intestinal coats and even the floor of the pericardiac chamber); we see them also, by employing sufficient magnifying-power, in the midst of the primitive muscular fibres, which they do not even equal in diameter; and some of those which I measured had a calibre of less than $\frac{1}{100}$ millim.

One of the most striking peculiarities of this vascular apparatus consists in its relations with the nervous system. Thus the abdominal artery, formed by the union of the two aortic branches, ensheathes the whole of the ganglionic chain: most of the nerves are lodged in the branches which spring from this median vessel.

These relations of the apparatus of innervation with the arterial system of the *Limuli* were perceived, although very imperfectly, by

Prof. Owen, and are more intimate than that eminent anatomist seems to think. In fact the nervous chain of these animals is not simply enveloped by the ventral blood-reservoir, and fixed to it in such a way as to be difficult to distinguish from it, but is enclosed in it; and this reservoir does not consist of a simple interorganic lacuna due to the disappearance of the arterial walls in this portion of the animal economy. It is not a case of juxtaposition of the nerves and arteries; it is a complete ensheathment of the former by the latter. The nerves destined for the integuments alone constitute an exception to this; they are free, and the vascular walls only accompany them to a small distance from their origin.

The principal arterial trunks open freely into one another, in such a manner that the blood can traverse a circulatory course without passing through the veins. These ways of communication are wide and easy; but there are others, formed by the terminal capillaries of the arterial system, which are continuous with the roots of the venous system. The latter is formed in part by interorganic lacunæ, in part by tubular vessels with perfectly distinct walls and presenting all the characters of true veins. This last mode of organization exists throughout in the substance of the liver. The hepatic veins open into a wide trunk situated on each side at the ventral part of the body, and giving origin to the afferent vessels of the branchiæ. The neighbouring muscles are arranged so as to act upon these venous trunks, and can cause alternately their contraction or dilatation. The blood which, by means of this mechanism, has traversed the respiratory apparatus, afterwards passes into the pericardiac reservoir.

The origin of the nerves which go to the different appendages enables us to determine the homologies of these parts, and to establish that in the *Limuli* there are no antennæ, as has been supposed by some anatomists. Lastly, I shall add that the visceral ganglionic system is not composed only of stomato-gastric and angeian ganglia in connexion with the œsophageal collar; there are also small nervous centres attached to the ganglionic chain, and furnishing branches to the terminal portion of the digestive tube.—*Comptes Rendus*, Dec. 2, 1872, pp. 1486-1488.

On the Boomdas (Dendrohyrax arboreus).

By Dr. J. E. GRAY, F.R.S. &c.

The British Museum has lately received three skins, with their skulls, of a species of *Dendrohyrax* from Elands-Post, South-east Africa.

They appear to be the Boomdas, *Dendrohyrax arboreus* of my monograph. This species was first described by Dr. Andrew Smith as *Hyrax arboreus*, and is known from the *D. dorsalis* of the west coast of Africa by the fur being much longer and softer, and the dorsal streak yellowish white; but the great difference is to be observed in the skull.